

AP/DPW

U.S.S.N. 10/719,550

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**  
**BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**



Appellants: Yang et al.

Group Art Unit: 1765

Serial No.: 10/719,550

Examiner: Chen, Kin Chan

Filed: 11/21/2003

In Response to Office Action  
Dated: 10/13/2006

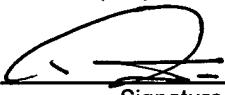
For: Semiconductor process residue removal composition and  
process

Attorney Docket No.: 67,200-1109(2002-1266)

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**REVISED APPEAL BRIEF**

Box Appeal  
Commissioner for Patents  
Washington, D.C. 20231

Sir:

APPELLANTS appeal in the captioned application from the Examiner's final rejection, dated 02/14/2006, of claims 1-3, 5, 7, 9-15, 17, 19 and 21-25.

It is urged that Examiners final rejection be reversed and that all the claims currently pending be allowed.

**(1) REAL PARTY IN INTEREST**

The real party in interest in the present appeal is the recorded Assignee, Taiwan Semiconductor Manufacturing Company, Ltd.

**(2) RELATED APPEALS AND INTERFERENCES**

There are no other appeals or interferences that are known to the Appellant, the Appellant's legal representative, or the assignee.

**(3) STATUS OF CLAIMS**

Claims 1-3, 5, 7, 9-15, 17, 19 and 21-25 are pending in the Application.

Claims 4, 6, 8, 16, 18, and 20 have been cancelled.

Claims 1-3, 5, 7, 9-15, 17, 19 and 21-25 stand rejected.

APPELLANTS appeal from the rejection of claims 1-3, 5, 7, 9-15, 17, 19 and 21-25.

**(4) STATUS OF AMENDMENTS**

A first amendment was mailed on or about 01/17/2006 and was

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entered.

An amendment after final was mailed on or about 5/12/2006 in response to Examiners rejections to overcome Examiners Rejections under 35 U.S.C. §112, first paragraph, removing offending language, adding specifically disclosed species (rather than generic term), and correcting a grammatical error to place the Application in better form for Appeal.

An Advisory Action was mailed on or about 05/24/2006 refusing entry of Appellants amendments after final, asserting that Applicants amendments "raise new issues".

**(5) SUMMARY OF CLAIMED SUBJECT MATTER**

Independent claims 1, 9, and 13 are directed to a process for solving the problem of removing oxidized metal residues from a metal structure following a planarization process (claim 1), and more particularly in claims 9 and 15 of removing oxidized metal (tungsten) residues from a metal plug following a planarization process (claim 9), and more particularly, a metal etchback process (claim 13) (see Appellants discussion of the problem presented in the prior art at paragraph 009, Specification).

For example, Appellants outline the shortcomings of prior art processes (paragraph 009) for removing residual tungsten

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particles following a tungsten etchback (planarization process) to form tungsten plugs (see paragraph 007; item 20, Figures 1B and 1C) including the formation oxidized tungsten residues including  $TiF_x(SO_n)_y(H_2O)_z$  (item 24; Figure 1C) following the etchback process and prior to forming an overlying metal layer (item 26, Figure 1D).

Appellants disclosed and claimed invention is directed to overcoming these shortcomings in the prior art.

Independent claim 1 outlines the method of:

"A process for removing oxidized metal residues from a metal structure, comprising the steps of:

providing a metal layer;

planarizing the metal layer to form a metal plug structure to leave metal residues on said metal plug structure;

providing an oxidant solution;

heating said oxidant solution to a temperature of at least about 60 degrees C; and

applying said oxidant solution to the metal plug structure to remove said metal residues comprising oxidized metal."

Independent claim 9 further specifies that the metal plug is a **tungsten plug** and the metal residues are **oxidized tungsten residues** but does not recite the claimed step in claim 1 of heating the oxidant solution.

Independent claim 13 further specifies that the planarization process is a tungsten etchback process to form a tungsten plug in a dielectric layer but does not recite the claimed step in claim 1 of heating the oxidant solution.

Figures 2B to 2F show the stepwise (paragraphs 0033-0036) formation of a tungsten plug (item 42) in dielectric layer (36) including a tungsten etchback process (without photoresist present) of a tungsten filling layer (40) (Figure 2B-2C; paragraph) to form oxidized tungsten residue (44; Figure 2D; paragraph 0035); removal of the oxidized tungsten residue according to the application of an oxidation solution (paragraphs 0017; 0031-0032; 0036) to the oxidized tungsten residue; and where removal of the oxidized tungsten residue enables subsequent formation of a metal layer (46; Figure 2F; paragraph 0037) on the tungsten plugs with improved electrical resistance.

With respect to claims 3, 7, and 11, 15, and 19, Applicants further claim that following the metal (tungsten) planarization (etchback) process, the oxidant solution is applied to the metal (tungsten) structure (plug 42; Figures 2C,2D) by spraying to remove oxidized metal (tungsten) residues (44;Figure 2C,2D) as explained in paragraph 0036 of the Specification.

With respect to claim 25 (dependent on claim 13) Applicants further claim a two-step etching process in a tungsten etchback process where a first etching step is carried out at a higher rate than a second etching step where the second etching rate is reduced to reduce loading effects to avoid tungsten recesses and where the second etching step is carried out at high selectivity to an underlying barrier layer (37; Figure 2C) (i.e., dielectric layer in claim 13) as explained in the Specification at paragraph 0035.

With respect to claims 21 (dependent on claim 1), 24 (dependent on claim 14) and claim 23 (dependent on claim 22 through claim 21), rejected as constituting new matter, Applicants claim the composition of the oxidant solution to include "alkanolamine" and "alkanolamines" (claims 21 and 24) and "diglycolamine" (claim 23) as explicitly set out in paragraph 0032 of the Specification).

**(6) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

1. Claims 13-15, 17, 19, and 21-25 stand rejected under 35 USC 112, first paragraph, as failing to comply with the written description requirement.

2. Claims 1, 2, 5, 9, 10, 12-14, 17, and 21-25 stand rejected under 35 USC 103(a) as being unpatentable over Lee et al. (US 2003/0228990) in view of Appellants alleged admitted prior art, as evidences by Chou (US 6,235,644), Shinohara (US 6,355,553) and Kadomura (US 5,227,337).

3. Claims 3, 7, 11, 15 and 19 stand rejected under 35 USC 103(a) as being unpatentable over Lee et al. in view of Applicants alleged admitted prior art, above, in further view of Wolf (Silicon processing, Vol. 1, page 51) or Verhaverbeke (US 5,972,123).

**(8) ARGUMENT**

**Rejection under 35 USC 112, first paragraph**

**Claims 13-15, 17, 19, and 21-25**

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1. Claims 13-15, 17, 19, and 21-25 stand rejected under 35 U.S.C 112, first paragraph, as failing to comply with the written description requirement. The claims contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventors, at the time the application was filed, had possession of the claimed invention.

A. Examiner alleges that in claim 13, line 7, "without photoresist present" is new matter. Examiner has failed to point out why and how one of ordinary skill would understand a tungsten etchback planarization process to not be understood by one of ordinary skill as being performed **without photoresist present** as **is clearly shown by Appellants in Figures 2B and 2C**, or as is demonstrated in Examiners cited art (see section 103 rejection below) to show that tungsten etchback is a "well-known" process.

Appellants further respectfully point out that the limitation was made to define over Examiners previous overly broad interpretation of the claims as Examiner previously applied two primary references **related to photoresist patterned etching processes and cleaning solutions to remove photoresist residue**.

"[I]n considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but also the **inferences which one**

**skilled in the art would reasonably be expected to draw therefrom.” *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968)**

The fundamental factual inquiry is whether the **specification conveys with reasonable clarity** to those skilled in the art that, as of the filing date sought, applicant was in possession of the invention as now claimed. See, e.g., *Vas-Cath, Inc.*, 935 F.2d at 1563-64, 19 USPQ2d at 1117.

**An adequate written description of the invention may be shown by any description of sufficient, relevant, identifying characteristics so long as a person skilled in the art would recognize that the inventor had possession of the claimed invention.** See, e.g., *Purdue Pharma L.P. v. Faulding Inc.*, 230 F.3d 1320, 1323, 56 USPQ2d 1481, 1483 (Fed. Cir. 2000).

Thus, it is clear that one of ordinary skill would appreciate that a **tungsten etchback planarization process is carried out without photoresist present**, and as **explicitly shown by Appellants in the Figures**.

See also MPEP 2173.05(i):

Note that a lack of literal basis in the specification for a negative limitation may not be sufficient to establish a *prima facie* case for lack of descriptive support. *Ex parte Parks*, 30 USPQ2d 1234, 1236 (Bd. Pat. App. & Inter. 1993).

Examiner has also not supported any assertion that such

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language constitutes new matter.

"Mere rephrasing of a passage does not constitute new matter. Accordingly, a rewording of a passage where the same meaning remains intact is permissible", *In re Anderson*, 471 F.2d 1237, 176 USPQ 331 (CCPA 1973).

"In order to satisfy the written description requirement, the disclosure as originally filed does not have to provide *in haec verba* support for the claimed subject matter", *Purdue Pharma L.P. v. Faulding Inc*, 230 F.3d 1320, 56 USPQ2d 1481 (Fed. Cir. 2000).

Thus, Examiner has failed to make out a *prima facie* case that Appellants language in claim 13 "without photoresist present" violates the written description requirement or constitutes new matter. See MPEP 2163.04(I):

In rejecting a claim, the examiner must set forth express findings of fact which support the lack of written description conclusion (see MPEP § 2163 for examination guidelines pertaining to the written description requirement). These findings should:

(A) Identify the claim limitation at issue; and

(B) Establish a *prima facie* case by providing reasons why a person skilled in the art at the time the application was filed would not have recognized that the inventor was in possession of the invention as claimed in view of the disclosure of the application as filed.

B. With respect to claims 21, 24 and claim 23, Examiner further asserts that the terms "alkanolamine" (claims 21 and 24) and "diglycolamine" (claim 23) is new matter, even though Appellants have previously pointed out explicit **in haec verba** support in the Specification in the previous office action and re-produce again paragraph 0032 of the Specification:

"Such oxidant solution includes about 4.56~8.05, and preferably, about 7.17 wt. % catechol; about 5.13~8.21, and preferably, about 6.93 wt. % **diglycolamine**; about 1.63~2.58, and preferably, about 2.21 wt. % gallic acid; about 11.70~13.44, and preferably, about 12.06 wt. % hydroxylamine; about 24.76~27.50, and preferably, about 26.03 wt. % moisture; about 22.46~27.94, and preferably, about 25.36 wt. % **monoethanolamine**; and about 18.98~23.02, and preferably, about 21.12 wt. % **monoisopropanolamine**."

Thus, Appellants have **explicitly disclosed two representative "alkanolamines"** (monoethanolamine and monoisopropanolamine) comprising an oxidant solution and have explicitly disclosed "diglycolamine" (misspelled as "dyglycolamine" in claim 23).

Examiner argues that the disclosure does not support such "a broad meaning" but cites no support for such an argument as supporting a claim of new matter. Rather the case law holds differently and finds that Applicants explicit disclosure of

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representative compounds justifies generic claims language:

(“[W]here no explicit description of a generic invention is to be found in the specification \* \* \* mention of representative compounds may provide an implicit description upon which to base generic claim language.”,  
*In re Robins*, 429 F.2d 452, 456-57,  
166 USPQ 552, 555 (CCPA 1970)

Thus, Appellants assert that Examiner is clearly in error in both his rejection under 35 USC 112, first paragraph or that Appellants language “without photoresist present” in claim 13, “alkanolamine” in claims 21 and 24, and correctly spelled “diglycolamine” in claim 23 constitutes new matter.

**Rejection under 35 USC 103(a)**

**Claims 1, 2, 5, 9, 10, 12-14, 17, and 21-25**

2. Claims 1, 2, 5, 9, 10, 12-14, 17, and 21-25 stand rejected under 35 USC 103(a) as being unpatentable over Lee et al. (US 2003/0228990) in view of Appellants alleged admitted prior art, as evidences by Chou (US 6,235,644), Shinohara (US 6,355,553) and Kadomura (US 5,227,337).

Examiner states that Chou, Shinohara, and Kadomura are not

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relied upon (see paragraph 5 of Office action) in rejection but only to support a statement that Appellants disclosed tungsten etchback process is "well-known".

Lee et al., discloses "A residue remover **for removing polymeric material and etch residue** (see Abstract, paragraph 0056) that includes 2-(2-aminoethylamino)-ethanol (AEEA) (see paragraph 0067) and optionally another two-carbon atom linkage alkanolamine compound, gallic acid or catechol, water, a polar organic solvent, and hydroxylamine.

Lee et al. teach that the solution may be used for removing **photoresist** or other residue from a substrate, such as an integrated circuit semiconductor wafer including **titanium metallurgy**"... "**without attacking titanium or other metallurgy** on the substrate". (see Abstract; paragraphs 0057-0058). Lee et al. further teach that the cleaning solution is used in a process operated at a temperature greater than 70 °C (preferably greater than 90°C) since it has a **low etch rate for a variety of metals when used at higher temperatures** (paragraph 0061, 0069).

Nowhere do Lee et al. **disclose a metal planarization including a metal etchback process, or oxidized metal residues, or an oxidant solution** for removing oxidized metal residues.

**Note that Appellants disclose that a commercially available oxidizer solution may be used in Appellants process (see Specification paragraph 0036)** which "may be the oxidant solution EKC270 available from EKC technology, Inc.", the assignee of Lee et al. (see **Specification** paragraph 0011). See also **Specification** paragraph 0039-0045 discussing various other cleaning and photoresist stripping solutions.

Examiner argues that Appellants alleged admitted prior art is relied on "only to **show the well-known tungsten etch-back process**". In a discussion of problems presented in the prior art Appellants recognize the problem of removal of etched tungsten residues including oxidized tungsten residues following a tungsten planarization process at **Specification** paragraphs 007 and 009:

"The most common method for removing the **tungsten residues 24** from the tungsten plug structure 9 is the wet scrubbing method, in which a jet of high-pressure deionized water sprayed against the structure 9. In addition, a scrubber brush may be simultaneously applied against the structure 9. The water jet is normally sprayed at a pressure of about 2,000-3,000 psi. **It has been found, however, that the wet scrubber method is ineffective in completely removing the tungsten residues from the tungsten plug structure prior to deposit of the top metal layer on the top dielectric layer and tungsten plugs.** While an in-situ post-etch bake

process may be used immediately after the tungsten etchback process to prevent formation of the residues, **this post-etch bake fails to remove the residues after they have formed.** Accordingly, a new and improved process for the removal of tungsten residues from a tungsten plug or other structure is needed."

With respect to the other references relied on to show the tungsten etch-back process is "well known", as Examiner asserts:

Chou discloses a three step tungsten etchback process where **a first etchback step is carried out and a second over etch process** is then carried out **to remove remaining metal residue**, followed by a gas flush and then followed by a second overetching process (see e.g., Abstract; claim 1). Nowhere does Chou recognize or suggest Appellants solution to the problem of metal etching residues on the plug **following the etchback process.**

Shinohara discloses a method for a two-step etchback process where **a smoothing layer is formed on a tungsten layer** prior to the **main planarization etchback process** which is then followed by a **second etch process where the deposition and etching rates of the first and second film are about equal to form a smooth surface on a tungsten plug** (see Abstract; claim 1). Nowhere does Shinohara recognize or suggest a solution to the problem **of metal etching residues on the plug following the etchback process.**

Kadomura discloses a two-step etchback process where the first (main) etchback process removes about 90% of the tungsten at a first temperature and **the second etchback process carried out at a second lower temperature to lower the etch rate** (see Abstract; claim 1). Nowhere does Chou recognize or suggest a solution to the problem of metal etching residues on the plug **following the etchback process.**

Thus, the fact that several different **tungsten (metal) etchback process** (planarization process) have been developed in the prior art to form a tungsten (metal) plug is **well known**, as Examiner alleges, does not help Examiner in producing Appellants invention.

"The fact that references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references." *Ex parte Levingood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993).*

Lee et al. does not disclose Appellants planarization or etchback process and none of the references recognizes or

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suggests a solution to the problem that Appellants have recognized and solved; removing **removing oxidized metal residues from a metal plug** following a planarization (metal etchback) process. Moreover, Lee et al. teach that the cleaning solution of Lee et al. (**for removing polymeric residues**) is for **preventing attack on metallurgy (e.g., Ti and Al)**, thus providing no motivation for applying the cleaning solution of Lee et al. to remove oxidized metal particles following a planarization or an etchback process. As noted, Lee et al. teach using the solution at a temperature of greater than 70°C **to avoid metal etching**. There is further no teaching or suggestion of the effect on **oxidized metal or oxidized tungsten** at those temperatures.

Moreover, any motivation for combining the teachings of Lee et al. with Appellants discussion of the prior art must impermissibly be found in Appellants disclosure and recognition of a problem to be solved.

With respect to claim 1, Lee et al. in combination with Appellants discussion of the prior art nowhere disclose or suggest the following elements of Appellants invention:

"A process for removing oxidized metal residues from a metal structure"

providing an oxidant solution;

heating said oxidant solution to a temperature of at least about 60 degrees C; and

applying said oxidant solution to the metal plug structure to remove said metal residues comprising oxidized metal."

With respect to claim 9, Lee et al. in combination with Appellants discussion of the prior art nowhere disclose or suggest the following elements of Appellants invention:

"A process for removing tungsten residues from a tungsten plug structure"

"providing an oxidant solution; and

applying said oxidant solution to the tungsten plug structure remove said tungsten residues comprising oxidized tungsten."

With respect to claim 13, Lee et al. in combination with

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Appellants discussion of the prior art nowhere disclose or suggest the following elements of Appellants invention:

"A process for removing residues from a tungsten plug structure having at least one tungsten plug and a tungsten layer"

"etching said tungsten layer in a tungsten etchback process without photoresist present to form a tungsten plug structure comprising tungsten residues on said tungsten plug structure;

providing an oxidant solution; and

removing the tungsten residues from the tungsten plug structure by applying said oxidant solution to the tungsten plug structure to remove said tungsten residues comprising oxidized tungsten."

With respect to claim 25, Lee et al. in combination with Appellants discussion of the prior art nowhere disclose or suggest the following elements of Appellants invention:

"wherein said tungsten etchback process comprises a first tungsten etching step at a first etching rate followed by a

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second tungsten etching step at a second etching rate less than the first etching rate to expose an underlying barrier layer."

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success **must both be found in the prior art, and not based on applicant's disclosure.**" *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

**Claims 3, 7, 11, 15 and 19**

3. Claims 3, 7, 11, 15, and 19 stand rejected under 35 USC 103(a) as being unpatentable over Lee et al. in view of Applicants alleged admitted prior art, above, in further view of Wolf (Silicon processing, Vol. 1, page 51) or Verhaverbeke (US 5,972,123).

Applicants reiterate the comments made above with respect to Lee et al.

With respect to claims 3, 7, and 11, 15, and 19, there is no motivation to combine the teachings of Lee et al. and Wolf or Verhaverbeke, other than that impermissibly found in Applicants disclosure. For example, Lee et al. teach producing compositions with higher flash points to enable operating safely at higher temperatures and to avoid metal etching. Lee et al. nowhere suggest or disclose applying the compositions by a spraying method, and moreover, such a process would likely defeat the purpose of Lee et al. in contacting metal with a composition at higher temperatures (preferably greater than 90 °C) to avoid metal etching and make the composition of Lee et al. unsuitable for its intended purpose.

Nevertheless, the fact that Wolf or Verhaverbeke disclose that applying a solution for wet etching or cleaning **can** include a spraying method, does not further help Examiner in producing Applicants disclosed and claimed invention or establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the

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reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

"If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

CONCLUSION

Even assuming *arguendo* that Examiner may find motivation to reproduce Appellants invention by attempting to modify Lee et al. by looking to Appellants disclosure and Appellants recognition of a problem in the prior art to be solved, such combination **does not produce or suggest** Appellants disclosed and claimed invention and is therefore insufficient to make out a *prima facie* case of obviousness.

Appellants additionally assert that Examiner has failed to make out a *prima facie* case, and is in error in asserting that claims 13-15, 17, 19, and 21-25 stand rejected under 35 USC 112, first paragraph, as failing to comply with the written description requirement or constitute new matter.

APPELLANTS disclosed and claimed invention has been demonstrated to be nonobvious since Examiner has failed to reproduce Appellants disclosed and claimed invention, or produce a reference that suggests the solution to the problem that Appellants have recognized and solved, even when looking to Appellants disclosure to impermissibly find motivation to modify the prior art. Moreover, none of the cited references other than Appellants own disclosure, recognize and solve the problem

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recognized and solved by Appellants disclosed and claimed invention.

The fact that Examiner can produce no references, alone or in combination, disclosing or suggesting APPELLANTS disclosed and claimed invention strongly supports a conclusion of patentability.

It is therefore respectfully submitted that Examiners final rejection of Appellants claims is improper under the statutory standard of 35 USC § 112, first paragraph, written description requirement and 35 USC § 103(a) as previously interpreted by both the Board and the Courts.

The reversal of the final rejection is respectfully solicited from the Board.

Respectfully submitted,

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CLAIMS APPENDIX

1. (previously presented) A process for removing oxidized metal residues from a metal structure, comprising the steps of:

providing a metal layer;

planarizing the metal layer to form a metal plug structure to leave metal residues on said metal plug structure;

providing an oxidant solution;

heating said oxidant solution to a temperature of at least about 60 degrees C; and

applying said oxidant solution to the metal plug structure to remove said metal residues comprising oxidized metal.

2. (original) The process of claim 1 wherein said oxidant solution comprises hydroxylamine.

3. (original) The process of claim 1 wherein applying said oxidant solution to the structure comprises spraying said oxidant

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solution onto the structure.

4. (canceled)

5. (original) The process of claim 1 wherein said heating said oxidant solution to a temperature of at least about 60 degrees C comprises heating said oxidant solution to a temperature of from about 60 degrees C to about 80 degrees C.

6. (canceled)

7. (original) The process of claim 5 wherein said applying said oxidant solution to the structure comprises spraying said oxidant solution onto the structure.

8. (canceled)

9. (previously presented) A process for removing tungsten residues from a tungsten plug structure, comprising the steps of:

    providing a tungsten plug structure formed by a planarization process to form tungsten residues on said tungsten plug structure;

    providing an oxidant solution; and

applying said oxidant solution to the tungsten plug structure remove said tungsten residues comprising oxidized tungsten.

10. (original) The process of claim 9 wherein said oxidant solution comprises hydroxylamine.

11. (original) The process of claim 9 wherein said applying said oxidant solution to the structure comprises spraying said oxidant solution onto the structure.

12. (original) The process of claim 9 further comprising the step of heating said oxidant solution to a temperature of at least about 60 degrees C prior to said applying said oxidant solution to the tungsten plug structure.

13. (previously presented) A process for removing residues from a tungsten plug structure having at least one tungsten plug and a tungsten layer, comprising the steps of:

providing a tungsten layer overlying a dielectric layer to fill an opening formed in the dielectric layer;

etching said tungsten layer in a tungsten etchback

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process without photoresist present to form a tungsten plug structure comprising tungsten residues on said tungsten plug structure;

providing an oxidant solution; and

removing the tungsten residues from the tungsten plug structure by applying said oxidant solution to the tungsten plug structure to remove said tungsten residues comprising oxidized tungsten.

14. (original) The process of claim 13 wherein said oxidant solution comprises hydroxylamine.

15. (original) The process of claim 13 wherein said applying said oxidant solution to the tungsten plug structure comprises spraying said oxidant solution onto the tungsten plug structure.

16. cancelled

17. (original) The process of claim 13 further comprising the step of heating said oxidant solution to a temperature of at least about 60 degrees C prior to said applying said oxidant solution to the tungsten plug structure.

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18. cancelled

19. (original) The process of claim 17 wherein said applying said oxidant solution to the tungsten plug structure comprises spraying said oxidant solution onto the tungsten plug structure.

20. cancelled

21. (previously presented) The process of claim 2, wherein the oxidant solution further comprises at least one alkanolamine.

22. (previously presented) The process of claim 21, wherein the oxidant solution further comprises catechol.

23. (previously presented) The process of claim 22, wherein the oxidant solution further comprises dyglycolamine and gallic acid.

24. (previously presented) The process of claim 14, wherein the oxidant solution further comprises, one or more alkanolamines, and catechol.

25. (previously presented) The process of claim 13, wherein said tungsten etchback process comprises a first tungsten etching step at a first etching rate followed by a second tungsten etching step at a second etching rate less than the first etching rate to

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expose an underlying barrier layer.

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**EVIDENCE APPENDIX**

None.

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Related Proceedings Appendix

None.